April 30, 1966

To:

Director
George C. Marshall
Space Flight Center, NASA
Huntsville, Alabama
Attn: Procurement & Controls Office
M-P&C-CA

Mr. R. Webber
M.I.T.
Room 5-112

Professor S. H. Crandall
M.I.T.
Room 3-360

Professor F. A. McClintock
M.I.T.
Room 1-302

Gentlemen:

   Enclosed please find the Nineteenth Quarterly Report for NASA Contract
NAS 8-2504. This is for the quarter ending March 31, 1966.

Sincerely,

John C. Heine

John C. Heine

JCH:kmc

Enclosure

ESTABLISHMENT OF GUIDELINES FOR RANDOM AND

SINUSOIDAL VIBRATION CORRELATION

NINETEENTH QUARTERLY REPORT

March 31, 1966

Both of the originally proposed[1] experiments have been completed this

past quarter. The material damping of three engineering alloys, 1080 steel,

416 stainless steel, and 2024-T4 aluminum has been studied by determining

the resonant responses of simple structural elements fabricated from these

alloys.

The structural elements were in the form of

(i)   torsional pendulums

and (ii) cantilever beams.

Photographs of both experimental apparatuses have been presented in previous

quarterly reports.[2,3] Specimens were fabricated from cold-drawn bar stock

and were not heat treated in any way.

A typical test consisted of determining the amplification factor at

resonance of a specimen at a series of stresses of up to 80% of the material

proportional limit. The mechanical amplification at resonance Q and the

specimen damping capacity g_s (the ratio of the total energy dissipated per

cycle in the specimen to 2π times the peak strain energy of the specimen

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[1]"Study of Material Damping Caused by Uniaxial and Biaxial Vibration
Stress Systems," Proposal for Extension for NASA contract NAS 8-2504.

[2]Eighteenth Quarterly Report for NASA contract NAS 8-2504.

[3]Nineteenth Quarterly Report for NASA contract NAS 8-2504.

in the cycle) are related by the equation

$$\frac{1}{Q} = g_s \tag{1}$$

In the remainder of this report, the term "damping" will refer to the magnitude of the specimen damping capacity.

The frequency and stress ranges in which each specimen configuration was tested and a discussion of the relationship between damping and stress and frequency are listed for each material below.

1018 STEEL

	FREQUENCY RANGE (cps)	STRESS RANGE (psi)
Bending Test	25 – 300	5,000 – 40,000
Torsion Test	60 – 400	2,500 – 20,000

DISCUSSION: (1) Bending test.- Both the damping and the relationship between damping and stress for this material was a function of frequency. Damping for low frequency tests, when transverse thermal current damping[4] would be a maximum, was substantially independent of stress amplitude and a function of frequency. A test run at a frequency at which thermal current damping was small, showed a marked stress dependence.

(2) Torsion Test.- Damping was stress dependent but frequency independent.

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[4] See, for example, Zener, C. M., "Elasticity and Anelasticity of Metals" Chicago: University of Chicago Press, 1948.

A final report is in preparation which details (1) possible mechanisms for the stress and frequency dependence of damping data for these alloys, (2) the experimental apparatus and test method used, and (3) correlation of bending and torsion data with possible applications for the computation of energy losses due to material damping in a structural member under a general state of biaxial stress. It is expected that this report will be completed by May 15, 1966.